NOTES AND OBSERVATIONS

A Gynandromorphic Northern Cardinal in Kendall, NY

A gynandromorphic Northern Cardinal (*Cardinalis cardinalis*) visited backyard bird feeders at the Kendall, Orleans County, NY, home of Gretchen and Harry Beaver, charter members of the Rochester Birding Association, throughout the months of January and February 2023. The bird was a clearly marked bilateral gynandromorph, with a vertical dividing line between its right side (female plumage) and its left side (male plumage). The homeowners requested that information about the sighting not be broadcast to the birding community, but they permitted RBA member Alan Bloom to come to their home to photograph it (photos p. 220).

Such birds are very rare, but they are not unheard of—in the northeastern states alone, individual gynandromorph Northern Cardinals have been reported in Pennsylvania and New Jersey, and an extremely rare Rose-breasted Grosbeak (*Pheucticus ludovicianus*) with half-male, half-female characteristics turned up in 2019 at Powdermill Natural Reserve near Ligonier, Pennsylvania (Carnegie Museum of Natural History 2020).

Although the Kendall cardinal was not captured and examined, similar birds have had both male and female gonads. The male/female divide in these birds originally led scientists to postulate that gynandromorphism was caused by sex hormones. Recent studies, however, have determined that the causes of this unusual phenomenon are not in the gonads, but in the chromosomes present in the cells and tissues showing male vs. female characteristics.

A groundbreaking study by Robert J. Agate *et al*. (2003) analyzed the contrasting phenotypes of the two sides of the brain of a gynandromorphic Zebra Finch (*Taeniopygia guttata*), compared with those of single-sex birds of the same species. Agate and his team discovered that the right half of the gynandromorph's brain had male genetic characteristics, while the left half was clearly female genetically. They concluded that the different sets of sex chromosomes present in these cells made a greater contribution to their sexual differentiation than its hormones, although they acknowledged that the bird's gonads played a role as well. Interestingly, the researchers placed this Zebra Finch in a cage with a female, and the gynandromorphic finch mated with the female, who produced several clutches of eggs. The eggs did not hatch and proved to be infertile. The researchers then placed the gynandromorphic finch in a cage with a normal male finch, and the normal finch treated the variant one with hostility, as if seeing it as competition for a mate.

Gynandromorphs are somewhat more common in chickens, with one in 10,000 turning up with this abnormality. Michael Clinton (2023) of the University of Edinburgh, Scotland, studied these at length and discovered that these chickens possessed a mix of male and female cells, while normal, single-sex chickens have either male cells or female cells. In an interview with National Public Radio when his study was published in the journal *Nature*, he said, "It's a really unscientific way of putting it, but it seems that these cells know whether they are male or female."

Clinton's findings changed the way science perceived sexual development in birds, and established the current understanding of the way birds develop the sexual phenotype. In a recent paper published online by Karger, Clinton noted that examination of tissue from both sides of gynandromorph birds "revealed that these animals were genuine male:female chimeras… It transpired that tissues that contained mostly male cells were of male appearance and tissues with a preponderance of female cells appeared female. This suggested that male (ZZ) tissues and female (ZW) tissues were either not responding to gonadal hormones, or responding in different ways to the same hormones." (Clinton and Zhao 2023).

Like mammals, birds have chromosomal sex determination, but the pattern is different in that homozygotic birds (ZZ) develop as males whereas heterozygotic ones (ZW) develop as females. Gynandromorphs are believed to develop from ZW zygotes that experience a mutation resulting in lineages of cells carrying just Z chromosomes (developing as male-looking tissues) and others carrying ZW (resulting in female-looking tissues). If the mutation occurs very early in development, the two lineages of developing cells can be arranged in the striking bilateral pattern observed in this case.

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